

PTO 04-1653

Japanese Patent

Document No. 564-79919

**MAGNETIC DISC AND METHOD FOR MANUFACTURING THE SAME**

[Jiki Disuku Oyobi Sono Seizo Hoho]

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UNITED STATES PATENT AND TRADEMARK OFFICE

Washington, D.C.

February 2004

Translated by: Schreiber Translations, Inc.

Country : Japan

Document No. : S64-79919

Document Type : Kokai

Language : Japanese

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IPC : G 11 B 5/66  
5/704  
5/706  
5/82

Application Date : September 22, 1987

Publication Date : March 24, 1989

Foreign Language Title : Jiki Disuku Oyobi Sono Seizo Hoho

English Title : MAGNETIC DISC AND METHOD FOR  
MANUFACTURING THE SAME

## Specification

### 1. Title of the invention

MAGNETIC DISC AND METHOD FOR MANUFACTURING THE SAME

### 2. Patent Claims

1. A magnetic disc with the following characteristics: In a magnetic disc wherein an undercoat layer and a ferromagnetic layer are laminated above a substrate, an undercoat layer metal(s) is diffused and locally deposited within the ferromagnetic layer by executing a thermal treatment after the formation of said ferromagnetic layer.

2. A magnetic disc specified in Claim 1 characterized by the fact that the aforementioned undercoat layer is made either of a metal selected from among Cr, Cu, Mn, Mo, Si, Ta, Ti, V, and W or of a corresponding alloy.

3. A magnetic disc specified in Claim 1 characterized by the fact that the aforementioned ferromagnetic layer is made either of Co or of an alloy consisting principally of Co.

4. A method for manufacturing a magnetic disc with the following characteristics: In a method for manufacturing a magnetic disc wherein an undercoat layer is configured above a substrate and wherein a ferromagnetic layer is laminated above said undercoat layer, the temperature is elevated, after the formation of the aforementioned ferromagnetic layer, to a level

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<sup>1</sup> Numbers in the margin indicate pagination in the foreign text.

equal to or higher than the crystalline phase transformation point of the substance that constitutes said ferromagnetic layer, and a magnetic field cooling treatment whereby the temperature is lowered within a magnetic field past said crystalline phase transformation point is subsequently executed.

### 3. Detailed explanation of the invention

(Industrial application fields)

The present invention concerns a magnetic disc and a method for manufacturing the same. More specifically, it concerns a magnetic disc with improved magnetic properties as well as a method for manufacturing the same.

(Prior art)

Generally speaking, excellent electromagnetic conversion attributes of a magnetic recording medium obtained by forming an intra-plane magnetization film on a disc-shaped substrate such as a magnetic disc, etc. are ascribed to the orientation of the magnetization-prone axis of the magnetic layer along the disc circumferential direction.

As far as coat-type discs are concerned, therefore, a technique wherein a magnetic field is impressed during the formation of a magnetic layer for the purpose of orientating the magnetization-prone axis along the circumferential direction, etc. is being utilized, whereas the aforementioned technique cannot be

applied to the vacuum deposition method, sputtering method, etc., which have come to capture attention as methods for forming media suitable for high-density recording purposes.

Attempts have, on the other hand, been made in the prior art to improve the magnetic anisotropy by means of a magnetic field cooling treatment whereby the temperature is lowered, after the formation of a magnetic layer, from a temperature higher than the crystalline phase /2

transformation point of the substance that constitutes said magnetic field past said phase transformation point within a magnetic field [T. Sanbongi and T. Mitsui, *Journal of the Physical Society of Japan*, Vol. 18, No. 9, pp. 1253 [sic], Sept., (1963)]. This method enables the use of a thin film magnetic disc, although magnetic properties suitable for high-density recording purposes have yet to be achieved.

(Problems to be solved by the invention)

The objective of the present invention, which has been conceived in acknowledgment of the aggravations of electromagnetic conversion attributes due to insufficient magnetic properties inherent in the aforementioned technique of the prior art, is to provide a magnetic disc endowed with excellent magnetic properties.

(Mechanism for solving the problems)

The present inventors discovered, as a result of incessant and extensive experiments and tests for many years, that a magnetic disc endowed with excellent magnetic properties can be obtained by forming, above a substrate, an undercoat layer made either of a metal selected from among Cr, Cu, Mn, Mo, Si, Ta, Ti, V, and W or of a corresponding alloy, by then laminating a ferromagnetic layer consisting principally of Co, and by then diffusing and locally depositing the undercoat layer metal(s) within said ferromagnetic layer by means of a thermal treatment. The present invention has been completed based on the foregoing insight.

The aforementioned thermal treatment is carried out by elevating the temperature to a level equal to or higher than the crystalline phase transformation point of the substance that constitutes the ferromagnetic layer and by then executing a magnetic field cooling treatment whereby the temperature is lowered past said phase transformation point within a magnetic field endowed with certain directional attributes.

During the phase transformation [fcc phase  $\rightarrow$  hcp phase] of this treatment, the ferromagnetic alloy consisting principally of Co comes to bear inductive magnetic anisotropy, namely the orientation of the magnetization-prone axis along the magnetic field impression direction. As a result of the aforementioned treatment, furthermore, the undercoat layer metal(s) becomes diffused within the ferromagnetic layer and locally deposited in

the crystal grain boundaries, whereas the coercive force becomes improved as a result of the size reduction of each magnetic zone.

The "crystalline phase transformation point" signifies a point at which a phase transformation either from the densest hexagonal lattice hcp of the Co or Co alloy into the plane-center cubic lattice fcc or from said fcc into said hcp occurs, whereas the concomitantly prevailing temperature is referred to as the "crystal transformation temperature." This temperature is a value specific to the concomitantly used Co or Co alloy. This crystal transformation temperature can be determined easily by persons of trade by repeating experiments.

As far as the manufacturing method of the present invention is concerned, a Co-type thin film ferromagnetic disc is subjected to a preliminary heating treatment at a temperature equal to or higher than the crystal transformation temperature. It is desirable, from the standpoint of maximizing the effect of the subsequent magnetic field cooling treatment, for said preliminary heating treatment to be executed at a temperature at least approximately 100°C higher than the crystal transformation temperature over a heating period of at least approximately 0.5 hour.

In a case where a Co-20 at% Ni alloy is selected for a ferromagnetic layer, for example, it is desirable to perform a preliminary heating treatment whereby the heating is continued for at least 1 hour at a temperature equal to or higher than 700°C, which is reported to be effective for triggering the phase

transformation with ease, and whereby the temperature is temporarily lowered to room temperature for the purpose of impressing a heat history. Next, the temperature is elevated to a level equal to or higher than the phase transformation point ( $\sim 400^{\circ}\text{C}$ ), and subsequently, the temperature is lowered, in a state where a magnetic field orientated along the disc circumferential direction is being impressed, to a level equal to or lower than the temperature at which the phase transformation becomes completed (e.g., room temperature). A phenomenal magnetic field cooling effects can be achieved as a result of such a treatment.

The aforementioned ferromagnetic layer consisting principally of Co may be constituted not only by Co alone but also by such alloys as Co-Ni, Co-Cr, Co-Ni-Cr, Co-Ni-P, Co-P, Co-V, Co-W, Co-Pt, Co-Ni-O, Co-Ni-N, etc.

These ferromagnetic layer and undercoat layer can be formed by any method selected from among the vacuum deposition method, sputtering method, ion plating method, ion beam deposition method, and the plating method.

Ones with high softening points and/or melting points, furthermore, are desirable as the aforementioned substrate, and as such, glass or ceramic substrates may be used. The magnetic anisotropy can, furthermore, be improved by forming a concentric texturing channel on the surfaces of these substrates.



(Application examples)

In the following, the present invention will be explained in further detail with reference to application examples.

#### Application Example 1

An undercoat layer (500 Å) made of Cr and a ferromagnetic layer (500 Å) made of Co-20 at% [sic] were laminated in proper order above a glass disc substrate with a diameter of 3.5" based on the sputtering method. Next, this disc was loaded into a vacuum tank, and after vacuum suction had been executed at an eventual magnitude of  $5 \times 10^{-7}$  Torr, a preliminary heating treatment was performed at 700°C over a 1-hour period. Subsequently, the temperature was lowered to room /3 temperature. After the temperature had then been elevated to 500°C, which is higher than the phase transformation point of the Co-20 at% [sic], the temperature was lowered, in a state where a magnetic field (3,000 Oe) was being impressed along the disc circumferential direction, to room temperature at a cooling rate of 3°C/min.

#### Application Example 2

A magnetic disc was prepared according to procedures similar to those in Application Example 1 except that the Cr undercoat layer of Application Example 1 was substituted with a W undercoat layer (500 Å) and that the intensity of the magnetic field during the magnetic field cooling treatment was changed to 5,000 Oe.

#### Comparative Example 1

A magnetic disc was prepared according to procedures similar to those in Application Example 1 except that the formation of the undercoat layer of Application Example 1 was dispensed with.

#### Comparative Example 2

A magnetic disc was prepared according to procedures similar to those in Application Example 1 except that the entirety of the thermal treatment of Application Example 1 was dispensed with.

#### Comparative Example 3

A magnetic disc was prepared according to procedures similar to those in Application Example 1 except that both the formation of the undercoat layer of Application Example 1 and the entirety of the thermal treatment of same were dispensed with.

The magnetic properties of each of the magnetic discs obtained in the respective application examples and comparative examples along the circumferential direction and radial direction thereof were measured by using a VSM (vibration-type sample magnetometer). Each disc, furthermore, was subjected to a torque measurement for the purpose of calculating its anisotropy constant  $K_u$ . The obtained results are summarized in Table I below.

Table I

Application Examples & Comparative Examples	Circumferential direction		Radial direction		Anisotropy constant Ku  x 10 <sup>4</sup>  (erg/cc)
	Hc (Oe)	S	Hc (Oe)	S	
1	780	0.86	600	0.68	6.8
2	750	0.85	550	0.68	7.0
1	450	0.88	320	0.70	6.8
2	410	0.80	410	0.80	1.0
3	120	0.89	120	0.90	1.0

As the foregoing table clearly indicate, the coercive forces and anisotropy constants of the magnetic discs obtained in Application Examples 1 and 2 are higher than those of the magnetic discs of the comparative examples, and thus, it is obvious that the magnetic discs of the present invention exhibit excellent magnetic properties by virtue of their anisotropy along their circumferential directions and that they are concomitantly endowed with favorable electromagnetic conversion attributes.

(Effects of the invention)

As the foregoing explanations have demonstrated, as far as the present invention is concerned, a magnetic recording medium endowed with excellent magnetic properties can be obtained by forming, above a substrate, an undercoat layer made either of a metal selected from among Cr, Cu, Mn, Mo, Si, Ta, Ti, V, and W or of a corresponding alloy, by then laminating a ferromagnetic layer consisting principally of Co, and by then performing a thermal treatment for inducing the diffusion and local deposition of the undercoat layer metal(s) within the ferromagnetic layer.

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